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Using Remote Sensing to Detect Land Change for the US Army Corp of Engineers' Poplar Island Restoration Project

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Land cover analysis and change detection of WorldView-2 imagery to assess efforts by the U.S. Army Corps of Engineers to restore Poplar Island, Maryland, USA

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Poplar Island Research Context

The Poplar Island Environmental Restoration Project is restoring the island by building numerous cells made of dredged material from the Chesapeake Bay. The cells on the island are made up of two different habitat types, wetland and upland. The choice to build two types of habitat is designed to foster a wider array of animal species and also to contribute to local ecological systems. (Derrick et al, 2007) Wetland habitats are open to the water and are close to sea level, while the upland habitats are protected by dikes and are built to be more elevated. Wetland habitats are made up of tidal marshes while the upland habitats are built on solid soil and rock and will be somewhat forested. The wetland cells that are currently constructed have vegetation growing, but the upland areas are mostly bare soil. The PIERP is planning on expanding the island to around 1600 acres.
Our research has three main objectives:

1.Determine the areal extent of Poplar Island as of August 2019 and how close that number is to the USACE's goal of 1600 acres.
2.Determine the distribution of wetland, bare rock/barrier, bare soil, water, human development land cover types.
3.Detect and assess vegetation trends of the last ten years as a reflection of restoration efforts.

Study Area Scene Model

Information required	Areal extent of Poplar Island in acres; total area and distribution of land cover classes; total cumulative area of vegetation patches
Environment type	Man-made island Chesapeake wetland habitat Upland habitat with trees
Spatial scale	Grain = ~1.84m Extent = Poplar Island, ~3mi^2
Temporal scale	Image was captured August 8, 2019
Components and hierarchy	Constraint: Poplar Island and surrounding water (~20-40 meter buffer around the island) Focus: 100 m^2 (50 pixels) vegetation patches Mechanism: individual plants
Spatial dimensions	H-Resolution grain: ~1.84 m extent: ~7.76996 km^2
Temporal dimensions	Selected date: August 8, 2019 Solar conditions: : 0°-20° zenith angles (11.30 a.m. - 2 hours) (12.30 p.m. + 12 hours) Acquisition time: 11.10 a.m., 11.5-ft MSL
Spectral dimensions	8 Multispectral bands 4 standard colors: red, blue, green, near-IR 4 new colors: red edge, coastal, yellow, near-IR2
Radiometric dimensions	11 bit

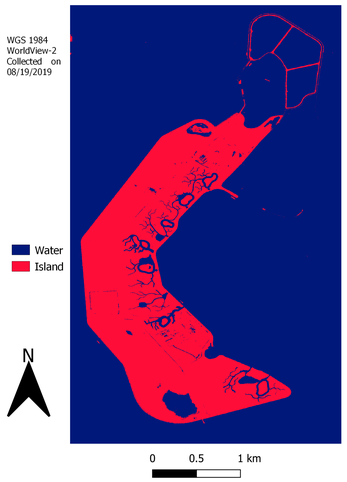
Poplar Island Land Cover

This study uses high-resolution WorldView-2 imagery to distinguish land cover in Poplar Island, MD.
The majority of Poplar Island is made up of constructed cells that are then filled in with dredged material. The restoration continues in transforming these cells into tidal wetlands of both low and high marsh, open water ponds, bird nesting islands, and upland. With the exception of upland and open water ponds, the land cover of Poplar Island is a mixture of water, bare soil, and vegetation land cover types. Even with the high spatial resolution of the WorldView-2 imagery, this land cover type still results in mixed pixels. The island land cover was unmixed using linear spectral unmixing based on endmember pixels of the following classes; built-up areas, barrier rock, bare soil, water, and vegetated wetlands.

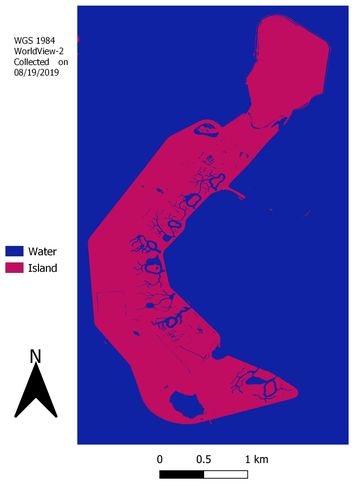
Poplar Island WorldView-2 Image Time Series and Areal Extent

Poplar Island continues to expand with the construction of new cells by the US Army Corps of Engineers. These cells are filled with material dredged from Chesapeake Bay shipping lanes and allowed to drain naturally.

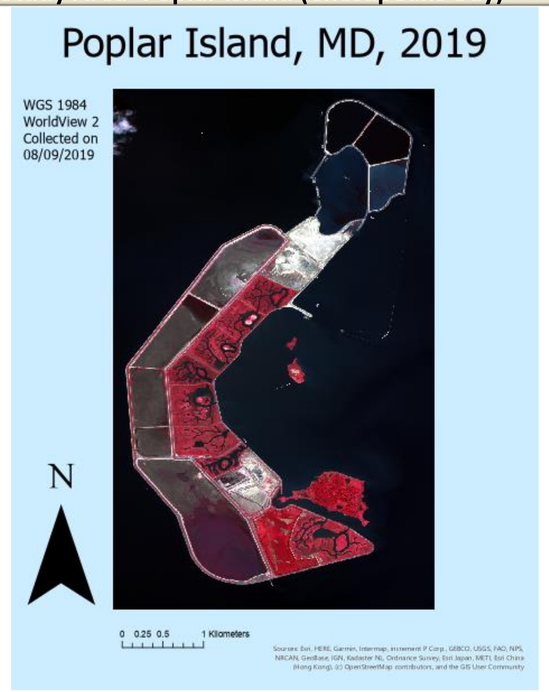
Poplar Island Areal Extent as of August 2019



Poplar Island with Filled Northern Segments



Study Area- Poplar Island (Chesapeake Bay)



Data Summary

Product	Processing	Date Collected	Source
WorldView-2 imagery	DigitalGlobe custom pre-processing algorithm that minimizes haze effects while preserving the full spectral information in reflectance pixel values, provides normalized surface reflectance values across every pixel, removes significant error in the comparison of images over time, and is compatible across both panchromatic and multi-spectral images.	19-AUGUST-2019 View angle: Accessible Ground Swath Nominally +/-40° off-nadir = 1355 km wide swath	Army Corps purchased from Digital Globe

Main Findings

Areal Extent

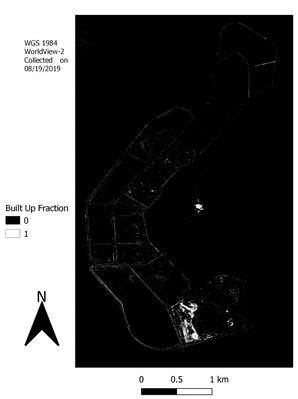
- The WorldView-2 imagery shows that the island's areal extent was 1139 acres in 2019, almost exactly at 1,140 acres expected by the USACE. When including for the northern segments of the island that were unfilled as of 2019, the total areal extent reaches 1383 acres which is still below the USACE's goal of 1600 acres.

Land Cover Distribution and Vegetation Trends

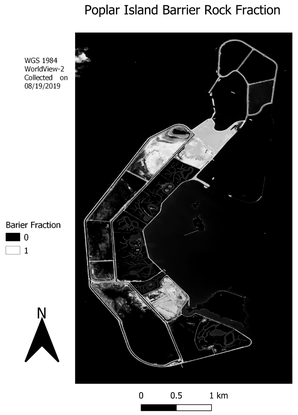
- Land cover mirrors what can be seen from visual inspection; the wetland cells are heavily composed of water and vegetation, while the undeveloped upland cells are mostly bare soil with very little biomass.
- Further land change analysis is needed to determine if vegetation is increasing with the areal expansion of the island.

Land Cover Fraction Images

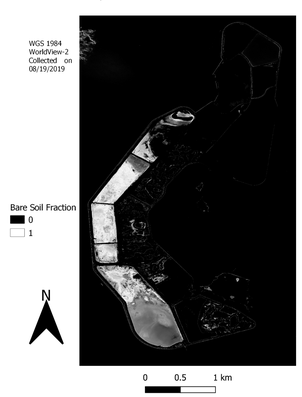
Poplar Island Built Up Fraction



Poplar Island Barrier Rock Fraction



Poplar Island Bare Soil Fraction



Poplar Island Water Fraction

Poplar Island Wetland Fraction

References

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Acknowledgements

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